Department of Energy
Oak Ridge Operations
Weldon Spring Site
Remedial Action Project Office
7295 Highway 94 South
St. Charles, Missouri 63304

March 13, 1998

Mr. Glenn Carlson
Missouri Department of
Natural Resources
Post Office Box 176
Jefferson City, MO 65102

Dear Mr. Carlson:

RESPONSES TO COMMENTS ON THE DRAFT FINAL VERSIONS OF THE QROU FEASIBILITY STUDY AND PROPOSED PLAN

Please find enclosed a package containing response to comments in the attachment to your letter dated February 11, 1998 regarding your review of the Draft Final versions of the QROU Feasibility Study and Proposed Plan. In addition, we would like to provide the following clarification to responses to comments or issues contained in the letter itself.

(1)Remediation Goals - Regarding the request to provide containment as a remediation goal, we feel that the current goal of achieving as much reduction as possible of the uranium present north of the slough is appropriate and adequate. Any reduction achieved is expected to provide additional protection to already acceptable and protective conditions at the St. Charles County well field. Note also that this action is being taken in addition to the protective measures already provided for in the *Well Field Contingency Plan*.

(2)Performance Goals - Although Alternative 6, Groundwater Removal at Selected Areas with On-Site Treatment; has been proposed as a preferred option, there are uncertainties associated with its implementation. The period of two years was determined to be an adequate period of time to verify these uncertainties. Therefore, it remains to be seen whether the reduction estimated could even be achieved. A two-year implementation of the proposed action is expected to either provide the 8% to 10% reduction in mass estimated or greater depending on how representative the assumptions are to actual site-conditions. If the reduction achieved is as estimated or greater, the goal of providing as much reduction as possible would have already been achieved. The implementation of the action beyond the two-year period proposed would not be cost-effective in light of the acceptable and protective conditions that exist in the well field and the contingencies already planned for the well field via the *Well Field Contingency Plan*. As per response #17 in the enclosed package, the DOE, EPA, and the MDNR have agreed to meet to discuss specifics regarding the proposed action. We hope to obtain input from the EPA and the MDNR at that time so that we could incorporate these into a final design package that would be optimal and acceptable to the EPA and the MDNR.

(3)Missouri Water Quality Criteria as Applicable or Relevant and Appropriate Requirements (ARARs) - We have identified the state standards for 2,4-DNT, 1,3-DNB, and nitrobenzene as applicable. The standard for nitrobenzene of 17 ug/L has not been exceeded in any of the monitoring wells. The standard of 1.0 ug/l for 1,3-DNB is exceeded only in one well where the reported maximum concentration based on current data is 3.5 ug/L; however, it is suspected that this data point could be an anomaly. Concentrations higher than typical were reported for other parameters analyzed for in this same sample and subsequent samples have returned to "no detect." From a review of current data, only three slight exceedences of the 0.11 ug/L standard for 2,4-DNT occur. Maximum concentrations of 0.18 ug/l, 3.5 ug/l, and 0.61 ug/l were reported for MW-1002, MW-1004, and MW-1006, respectively. We expect concentrations to continue to trend downward with time as a result of bulk waste removal as reflected by data collected since 1996. The need to remediate for nitroaromatic compounds is not warranted; these low levels equate to risks within the acceptable risk range (for both hypothetical residential and recreational use scenarios) recommended by the EPA. We proposed that the monitoring component of Alternative 6 be allowed to occur for a certain time period before a decision is made regarding need for ARAR waivers for the nitroaromatic compounds. Text similar to this would be included in the proposed plan to address the request from the MDNR.

(4)Remedial Design Issues - Again, we would like to refer you to response #17 in the enclosed package. Your input can be provided at the upcoming discussions. Also, it is more appropriate for discussions of specific design to be presented in upcoming remedial design/remedial action documentation.

We hope that our responses provide the clarification that you requested. Please contact Karen Reed or myself if you need further information.

Sincerely,

Stephen H. McCracken
Project Manager
Weldon Spring Site
Remedial Action Project

copy: Dan Wall, EPA
Larry Erickson, MDNR
Bob Geller, MDNR
Weldon Spring Citizens Commission
Gene Valett, PMC
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Responses to Comments on the Draft Final Feasibility Study and Proposed Plan for Remedial Action for the Quarry Residuals Operable Unit at the Weldon Spring Site, January 8, 1998

#	Comment #, page, Section, Paragraph, etc.	Comment	Response
MDNR Comments			
1.	204.	DOE continues to cite EPA guidance ("Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites," EPA/540/G-88-003, OSWER Directive 9283.1-2, December 1988) as authority for its statement, "A reasonable time is defined to be 100 years." While at p.5-2 of the cited EPA guidance is the statement, "The restoration time frame is defined as the period of time required to achieve selected cleanup levels in the ground water at all locations within the area of attainment," we can locate no statement in the cited document which *defines* 100 years as a reasonable time. Other EPA guidance addresses reasonable restoration timeframes differently. "Defining a reasonable time frame is a complex and site-specific decision." *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, OSWER 9200.4-17, December 1, 1997. "Although restoration timeframe is an important consideration in evaluating whether restoration of ground water is technically impracticable, **no single time period can be specified which would be considered excessively long for all site conditions.**" Emphasis added. *Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites*, EPA 540/R-96/023, OSWER Directive 9283.1-12, October 1996. "While restoration timeframes may be an important consideration in remedy selection, no single timeframe can be specified during which restoration must be achieved to be considered technically practicable. However, very long restoration timeframes (e.g., longer than 100 years) may be indicative of hydrogeologic or contaminant-related constraints to remediation." *Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration*, OSWER Directive 9234.2-25, September 1993. Please identify the page in the document cited by DOE which defines 100 years as a "reasonable time." If no such definition can be found, determine a site-specific reasonable timeframe and reevaluate the necessity for a technical impracticability waiver considering this site-specific value.	The document *Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites* (EPA/540/G-88-003) contains a number of examples. One example is provided in the last sentence of the first paragraph of Section 5.3.3.2 on page 5-8: "If levels of contaminants are projected to attenuate, a waiver may not be necessary if cleanup levels will be achieved in a reasonable time frame (i.e., less than 100 years)." Another example is provided in the last sentence of the first paragraph of Section 6.2.2.3 on page 6-2: "A time frame beyond 100 years would generally warrant the technical impracticability waiver."

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2	205. FS, Page 1-9, Figure 1.5	Figure 1.5 lacks a legend that would allow identification of the strata and symbols used in the figure.	Comment noted. Figure has been revised as suggested.
3.	206. FS, Page 1-17	The Little Femme Osage Creek may have been impacted by the quarry through overland flow or secondary porosity features.	Metals and nitroaromatic compounds have been detected at levels greater than background in the Little Femme Osage Creek. Nitroaromatic compounds were detected in the locations upgradient from the quarry, suggesting the source to be the WSOW. As outlined in the response to comment #84, there has been no evidence of surface water discharges to the Little Femme Osage Creek. The static water level of the quarry pond (prior to bulk waste removal) fluctuated around 465 ft MSL. A high water mark of 467 MSL has been documented. The ground elevation along the western side of the quarry is 483 ft MSL, suggesting that "over-topping" of the pond was not likely. The USGS investigated the surface water/groundwater interaction of the Little Femme Osage Creek in the vicinity of the quarry through the use of seepage runs (USGS, Water-Resource Report 96-4279). Based on this study, gains or losses of streamflow in the Little Femme Osage Creek near the quarry are minimal, and therefore, little exchange of water occurs between the underlying bedrock and the Little Femme Osage Creek. This would indicate that groundwater flow though secondary porosity features, if occurring, have not contributed to the impact in the creek.
4.	207. FS, Page 1-18, Section 1.2.3	Indicates that the reducing zone has halted plume movement. That is not known with certainty. Co-location may be coincidental or may reflect a lack of dilution in this part of the alluvium as suggested elsewhere in the report.	It has not been suggested that reduction is the only mechanism which has resulted in the sharp decrease in uranium levels north of the slough (see RI section 10), but based on supporting data, the geochemistry of the area supports the reduction of dissolved uranium in the groundwater. An additional factor which has aided in the retardation of uranium in groundwater is the adsorption of uranium onto the soils north of the slough which also results in a decrease of uranium in groundwater as it passes through these clayey and organic-rich soils. True, the effects of dilution are less in the area north of the slough than south of the slough, but if only dilution were the active process, the concentration gradient in the plume would be more gradual than that observed in the monitoring wells and in-situ points.

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5.	208. FS, Page 1-20	Where did the other metals come from, if not from the bulk waste?	Aluminum, iron, manganese and thallium were detected at elevated concentrations but are not considered to be derived from the bulk waste. The likely source of aluminum is incusion of naturally occurring sediments and colloidal clay particles in groundwater samples. Iron and manganese also occur naturally in aquifer minerals which is considered to be the source of these metals. Thallium occurrences in groundwater have been sporadic, and thallium was only detected in low levels in the bulk waste. Because of a problem with high detection limits, the concentrations may not be elevated over background levels. Additional sampling for thallium is being performed to determine whether concentrations are actually elevated.
6.	209. FS, Page 1-26	How close was the 14 pCi/L detection to the Little Femme Osage Creek? If it is close to the Creek, is it reasonable to consider it to be background?	The Darst Bottom background sampling locations are upgradient of the creeks and would not be impacted by the site.
7.	210. FS, Page 2-7	Contrary to statements here, the Plattin <u>is</u> in hydraulic communication with the alluvium.	There is no statement on pg. 2-7 that states or suggests that the alluvium is not in hydraulic communication with the Plattin. On the other hand, the alluvium is not in direct contact with the Plattin north of the slough. The Decorah separates these two formations in this area (DOE 1997b). As stated on pg. 2-7 "there is little vertical hydraulic connection" between the Plattin and the alluvium because the groundwater flow is generally in a south to southeast direction (i.e. horizontal flow) from the bedrock into the alluvium (DOE 1997b).

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8.	211. FS, Page 2-24	Contrary to statements in Table 2.5, hydraulic containment is possible. The statements regarding the sloping base of the alluvium are not understood.	Table 2.5 is a summary table that accurately reflects Section 2.2.3.2 on hydraulic containment. Section 2.2.3.2 was added to the document at the request of MDNR. However, as mentioned at the time of the request, the concept of hydraulic containment is very broad and most aspects were already present in the FS under sections dealing with containment, in the form of barrier walls, and groundwater removal, using vertical or horizontal wells and interceptor trenches. As mentioned in Section 2.2.3.2, any form of pumping would result in removal and the need for treatment, thus such pump-and-treat operations were discussed in Section 2.2.5 on groundwater removal. A short discussion on vertical wells and pressure ridges (the only method not previously discussed in the FS) was presented in the hydraulic containment section (Section 2.2.3.2). Vertical wells and pressure ridges are not expected to be effective north of the quarry for the reasons outlined in Section 2.2.3.2, thus hydraulic containment, as discussed in Section 2.2.3.2, is not expected to be possible. Under ideal conditions, vertical wells will establish a well-defined isotropic capture zone that is perpendicular to the groundwater flow in an homogenous, isotropic aquifer (EPA 1996). In a non-isotropic aquifer, such as one with a sloping base, the ideal geometry is distorted and an inward hydraulic gradient may not be able to be maintained (Cohen 1994), causing loss of containment.
9.	212. FS, Page 3-6	This language implies that contamination will reach the County Well Field before action is taken. Language on page 3-46 is preferable, assuming that the plan is to prevent impact to the County Well Field.	Statement will be revised to state: "Contingency measures would be considered if data indicate that potential unacceptable exposure concentrations would appear at the St. Charles County well field."

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10.	213. FS, Page 4-6	The frequency for highly contaminated wells located in the middle of plumes can be fairly low. The highest frequency should be for wells located at the downgradient margins of the plume(s). Some wells may be added surrounding the downgradient edge of the current system. New wells should be sampled quarterly to establish a data set for each well and to provide a reliable measurement of aquifer condition at each new well. The Darcy velocity should be used in conjunction with the well spacing to determine sampling frequency. Travel times between wells and the edge of the plume or trigger locations for further action can be estimated using Darcy velocity. Sampling frequency is then set to insure detection of any further plume movement.	The approach provided in this comment may be considered during optimization of the existing groundwater monitoring system. Other factors may also be important such as the contaminant concentration level and cost. For example, if the maximum concentration of a contaminant continuously declines below the cleanup level for five consecutive years, then no further monitoring of those wells may be warranted. A number of methods exist for optimization of a long-term groundwater monitoring program. One resource is the draft final document titled "Long-Term Monitoring Optimization Guide" developed for the U.S. Air Force Center for Environmental Excellence, and is available on the Internet at the URL: http://www.wpi.org/afcee/ltm/. Another example is the protocol called cost-effective sampling (CES) developed by Lawrence Livermore National Laboratory and Savannah River Technology Center and highlighted in the following document: • Ridley, M., 1995. *Cost-Effective Sampling of Groundwater Monitoring Wells*, The Regents of University of California/Lawrence. It should be noted that even after implementation of a groundwater remedy, refinements will be generally be needed because of the long time period over which the remedy will operate (Section 2.3 on page 12 of EPA/540/R-96/023). For example, adding a few additional monitoring wells should be considered a minor modification to a remedy that includes a relatively large number of such wells. The above-cited documents, information provided in the comment, and other resources would be considered in the development of the details of the long-term monitoring program for this operable unit, and as stated in the text of the draft QROU FS on page 4-6, "will be presented in subsequent reports prepared for this operable unit, as appropriate."

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11.	214. FS, Page 4-18	The EPA guidance regarding TI also states that the agency would expect to require an alternative remedial strategy that is technically practicable, consistent with the overall objectives of the remedy and controls the sources of contamination and human and environmental exposures. What would this alternative remedy be in this case? Containment is a valid alternative remedy and may be adequately executed hydraulically through Alternative 3 or 6. Also, the guidance states that thorough site characterization is essential. Since characterization is not adequate to closely evaluate the redox conditions or the actual retardation of the uranium, can DOE state that this standard has been net? These issues also have a significant affect on the projected efficacy of the various proposed and excluded remedies. The National Research Council, in *Groundwater Models, Scientific and Regulatory Applications* (ISBN 0-309-03996-7) states: "The processes associated with transport modeling are greatly compounded when the solutes are reactive. In this case, chemical rather than hydrologic processes govern the behavior of a contaminant plume." "Most models of reactive solutes are based on small-scale laboratory studies, which may not accurately mimic conditions found in the actual subsurface environment." "Although models for important reactions like oxidation/reduction, precipitation, and biodegradation exist, they are complicated to formulate and solve, difficult to characterize in terms of kinetic parameters, and largely unvalidated in practical applications. Thus, the transport of multiple reacting constituents such as trace metals and organic compounds cannot be modeled with confidence." Region VII guidance also required "Demonstration that available technologies could not achieve cleanup levels within a reasonable time frame due to limitations imposed by site characteristics." Also: "In any case, it is important where 'complete' cleanup is impracticable, to have a way of demonstrating the effectiveness of the best practicable site-specific remediation strategy." This demonstration is different than the predictive analysis already offered by DOE. Finally, OSWER Directive 9234.2-25 states: "Restoration timeframe analyses, therefore, generally are well suited for comparing two or more remediation design alternatives to determine the most appropriate strategy for a particular site. Where employed for such purposes, restoration timeframe analyses should be accompanied by a thorough discussion of all assumptions, including a list of measured or assumed parameters and quantitative analysis, where appropriate, of the degree of uncertainty in those parameters and in the resulting timeframe predictions.	ANL is not aware of any guidance within the appropriate EPA guidance expecting an alternative remedial strategy that is technically practicable for contaminated groundwater sites. It should be noted that the document *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (OSWER Directive 9200.4-17, Nov. 1997; available at http://epa.gov/swerust1/directiv/9200_417.htm) states on page 11 that "When restoration of groundwater is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction. Consideration or selection of monitored natural attenuation as a remedy or remedy component does not in any way change or displace these (or other) remedy selection principles." The statements within the above-cited document appear to disagree with the intent of this comment.

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12.	215. FS, Page 4-19	The "heterogenous underlying stratigraphy" and "complex geology" are mute points when an interceptor trench is used at the downgradient margin to intercept the plume(s).	As noted on page 3-22 of the Draft Final QROU FS, Alternative 6 would involve extraction and treatment of the quarry groundwater in areas of localized high contaminant levels, and as shown in Figure 3.7 on page 3-25, would not be located (completely) downgradient of the uranium contaminated zone. Therefore, an assessment of the potential for groundwater to flow from the quarry area without being intercepted by the proposed groundwater extraction system would depend, in part, on the "heterogeneous underlying stratigraphy" and the "complex geology."
13.	216.	The document named above does not bear the seal of a geologist who is registered in the State of Missouri. The document incorporates or is based on a geologic study or on geologic data that had a bearing on conclusions or recommendations reached after January 1, 1997. The Missouri Board of Geologist Registration is charged with the enforcement of the Missouri Geologist Registration Law that includes the requirement that geologic work where public health, safety or welfare are at risk or potentially at risk be completed by or under the direct supervision of a geologist registered in Missouri. The following review comments and/or recommendations convey no endorsement as to the validity of the work being completed in accordance with the Missouri Geologist Registration Law or the Board of Geologist Registration. Further, the review comments and/or recommendations cannot be accepted as being fully completed until the reviewed document is properly sealed/stamped by a geologist registered in Missouri in accordance with the law and the rules as administered by the Board.	A seal of an ANL geologist who is registered in the State of Missouri has been provided in the final copy of the FS.
14.	217.	MDNR and the DOE have not yet resolved the issue of the point of compliance. For example, see the response to Comment #142.	Page 19 of the document *Rules of Thumb for Superfund Remedy Selection* (EPA/540-R-97-013, August 1997) stated that "Final cleanup levels for contaminated ground water generally should be attained throughout the entire contaminant plume, except when remedies involve area where waste materials will be managed in place. In the latter case, cleanup levels should be achieved 'at and beyond the waste management area when waste is left in place.'" The document EPA- 540/R-96/023 (October 1996) states on page 18 that "thus, the edge of the waste management area can be considered as the point of compliance, because ARAR or risk-based cleanup levels are not expected to be attained in ground water within the waste management area." This would imply that the point of compliance would be located downgradient of the uranium-contaminated zone north of the Femme Osage Slough; based upon this interpretation, the point of compliance would then be the RMW monitoring wells south of the Femme Osage Slough.

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15.	218. Response to Comment #165:	It has previously been proposed that the uranium detected in the bentonite grout used in a new monitoring well originated at the bentonite source and was not absorbed from contaminated site groundwater, as suggested in this response.	The source of the uranium detected in the bentonite grout originated at the bentonite source and not from the contaminated site groundwater. The text will be revised to reflect this point.
16.	219.	We partially disagree with the response to Comment #172. There are no hydrological reasons why the truncation of the Decorah Group would prevent groundwater migration beyond the slough area. No hydrological barriers such as an aquitard or fault are present. The probability of bedrock discharge to the Missouri River alluvium is discussed on page 1-10 of the FS (DOE 1998).	The Plattin Limestone, which is the uppermost bedrock unit south of the slough, has been characterized to be the least fractured unit impacted by the quarry. Migration of uranium into the alluvium south of the slough could occur in the fractures in the Decorah Group. Based on fracture analyses, where this unit is the uppermost bedrock (north of the slough), it has a higher occurrence of fractures. Since this unit is truncated at a point coincident with the slough, this migration pathway does not extend for any distance into the alluvial materials south of the slough (i.e. into the well field). It is not suggested in the original response that the truncation halts the migration of uranium but is not a pathway deep into the well field.
17.	220.	Usually, in a Feasibility Study, a proposal for a long-term remedy to remediate, in this case, contaminated groundwater is made. Alternative 6 falls short of this goal. The active phase of Alternative 6, due to its limited duration, two years or less, is considered a pilot project rather than a long-term remedy. GSP suggests that after the first two years of operation, that an evaluation be conducted to determine if specified performance criteria have been achieved. Then a decision should be made whether or not to continue the active groundwater extraction and treatment.	The primary objective of the FS for the QROU was to evaluate alternatives to identify one that could provide reduction and/or removal of the uranium in groundwater north of the slough. Alternative 6 has been identified as one that could possibly provide some reduction. However, uncertainties related to its implementation have to be verified. The DOE and the EPA and MDNR have agreed to meet to discuss performance criteria and other details related to the proposal before final designs are put in place. The expectation is that it would be at this time (i.e., during the discussions) that specific input from all parties would be considered and incorporated into the final design
18.	221. Section 1.1.1, Site History and Description, p. 1-6, paragraph 4	Please identify the source of the soil to be used for the engineered soil to be used to cover fractures at the bottom of the quarry.	The restoration of the quarry is being performed primarily to mitigate the safety concerns with respect to exposed highwalls of the quarry. Based on the design of the restoration backfill materials, specifications for acceptable source materials will be made and materials verified to meet these specifications.
19.	222. Section 1.1.1, Site History and Description, p. 1-6, paragraph 4	It was stated by the DOE at the December 9, 1997 meeting attended by the MDNR, the EPA, and Argonne National Laboratory representatives, that the quarry fractures would be grouted with bentonite. The use of bentonite to seal the quarry fractures is not discussed in this section. Please describe how the backfill will be "engineered to reduce the potential for mobilization of residual contaminants into the groundwater" if the fractures are not first sealed with bentonite.	Quarry restoration is being performed primarily to mitigate the safety concerns with respect to exposed highwalls of the quarry, but it is expected that this action will have an effect on the residuals remaining in the quarry proper. The evaluation of "sealing" the fractures with bentonite or other substances, if necessary, will be a function of the restoration design and therefore is not outlined in the Feasibility Study.

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20.	223. Section 1.1.1, Site History and Description, pp. 1-6 through 1-7	Please explain what techniques will be used to "force groundwater flow to go around the inner quarry area, or alternatively, cause the groundwater within the footprint of the inner quarry area to pass through an attenuation layer to prevent the flow of contamination". Please explain how these actions will be coordinated with Alternative 6.	The restoration of the quarry is being performed primarily to mitigate the safety concerns with respect to exposed highwalls of the quarry but it is expected that this action will have an effect on the residuals remaining in the quarry proper. Assessments have been scoped which will evaluate the effects of backfilling the quarry with soils of differing permeabilities on groundwater flow. It is expected that materials with low permeabilities will impede groundwater movement through the area where the quarry sump is located. Conversely, it is expected that materials with higher permeabilities will allow groundwater to pass through the quarry area. Based on the results of these assessments, the restoration design will outline which types of backfill material is preferable.
21.	224. Section 1.1.2.1, Soil and Geology, p. 1-7, paragraph 2	Two major soil units, the Ferrelview formation and glacial till, have been left out of the description of the Weldon Spring upland soils.	The Ferrelview Formation and glacial till are not present at the quarry. The quarry is located south of the boundary of glacial activity in the Weldon Spring area.
22.	225. Figure 1.5, p. 1-9	WE did not comment on this figure previously, but would like to recommend that the units in the cross-section be identified. Of particular interest are the lens shaped units located between the units presumed to be the Kimmswick Limestone and Decorah Group. The graphics are also misleading; the pattern used to identify the presumed loess unit above "Kimmswick" at the quarry proper is also used beneath the upper fine alluvial unit. Revisions to this figure are in order.	The figure has been revised.
23.	226. Section 2.2.2, Natural Processes, p. 2-5, paragraph 2	It has been previously stated in QROU documentation that no reduction of uranium has been detected. That information is contradictory to the last sentence in this paragraph which states, "At least one of the natural processes mentioned above is responsible for the slow reduction with time of the uranium concentration in other locations within the aquifer". Please identify the "other locations within the aquifer" where uranium reduction has reportedly occurred.	Some wells in the contaminated area north of the slough appear to have decreasing levels of uranium contamination since removal of the bulk waste from the quarry. Below are a list of the wells with the most significant decreases in concentration. Average concentrations of uranium reported are given for the period prior to 1996 and for the samples taken in 1996 and 1997. Average Uranium Concentration (pCi/L) Well — Prior to 1996 — 1996/1997 MW-1005 — 3908 — 2620 MW-1015 — 710 — 234 MW-1016 — 350 — 176 MW-1030 — 133 — 41

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24.	227. Figure 3.6, p. 3-24	No narrative is provided to explain what is meant by "Series 1" and "Series 2". Please explain. Also please describe how the data points on this graph were derived. Approximately 95 years are omitted from this graph; it would be of interest to see the mass of uranium remaining after 25 and 50 years (i.e., or when thresholds of 50% and 75% reduction would be achieved).	The following text will be added after the first sentence of the first paragraph on page 3-23: "The reduction in the mass of uranium shown in Figure 3.6 was estimated using the following equation: $U\% = 100\% - \{ Q\,t\,(60\ \text{min/hr})\,(24\ \text{hr/day})\,(365\ \text{day/yr})\,(3.785\ \text{L/gal}) / UIM \} \sum_{I=1}^{n} c(t_i)$ where U% = percentage of uranium remaining in groundwater at time "t" (%); $c(t_i)$ = contaminant concentration collected by the interceptor trench (pCi/L) at time "t_i", defined in equation B.4 on page B-4; t = time interval of interest (yr); n = number of years (dimensionless, equal to t/1 year); t_i = I (years); Q = groundwater flow rate through interceptor trench (assumed to be 20 gpm). UIM = initial mass of uranium in groundwater, prior to treatment (8×10^{11} pCi, equivalent to 1,200 kg); (The above method is a numerical approximation to the integration of equation of B.4 with respect to time; the actual integration of equation B-4 was expected to be very difficult due to the involvement of the error function.) The variation in the plume width W_p and distance L in equation B.4 (see Section B.2) is represented in Figure 3.6 as two series, with Series 1 indicating the edge of the plume furthest from the interceptor trench and Series 2 the closest edge of the plume."
25.	228. Section 3.4.4.2, Implementability, p. 3-41, paragraph 2 and Section 3.4.6.2. Implementability, p. 3-48, paragraph 1	Following industry standards, to properly key into the bedrock, the trench bottom should be extended through the weathered, uneven bedrock surface to the unweathered portion, thus reducing the potential for leakage. Refer to Section 4.3, p. 4-12, paragraph 1 for further details.	The comment is correct. It should be noted that the description of the interceptor trench concept within the QROU FS is intended to be a preliminary design developed primarily for implementability and cost purposes. A more detailed design would be developed if this alternative would be selected as a potential remedy.

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26.	229. Section 3.4.6.1, Effectiveness, p. 3-47, paragraph 3	Please explain what would cause the "dilution of the coarse-grained materials south of the slough".	The comment identifies an unclear statement. The last sentence of the second paragraph on page 3-47 will be revised to state: "The concentrations of contaminants in the area of the quarry ...., and because of attenuation of uranium by sorption and redox mechanisms north of the slough and dilution with water infiltrating from the Missouri River within the coarse-grained materials south of the slough."
27.	230. Section 4.3 Alternative 6: Groundwater Removal at Selected Areas, with On-Site Treatment, p. 4-13, paragraph 2	The description of the geofabric installation in this section is inconsistent with both Figure 3.2 and the text description of page 3-9. On page 3-9, it is stated that the geofabric will only be placed on the trench bottom, while in Figure 3.2 the geofabric is shown lining the sides, as well as the trench bottom. According to the text on page 4-13, geofabric will also be placed around the top of the gravel prior to backfilling with soil. This would prevent downward migration of clay materials into the gravel which in turn could prevent clogging of the perforated pipe. GSP has previously commented on the geofabric design, stating that it would be most prudent to install the geofabric completely around the gravel layer.	The comment is correct and this preliminary design will assume installation of the geofabric completely around the gravel layer. The first sentence of the last paragraph on page 3-9 will be revised to state: "After construction of the interceptor trench, a geotextile fabric would be placed in the bottom of the trench with enough material to completely cover the gravel layer, and a perforated pipe would be laid on top of the geotextile fabric at the bottom of the trench."
28.	231. Section 4.3.2, Compliance with Potential ARARs, #5 Hydraulic Conductivity of the Contaminated Aquifer (less than 1×10^{-4} cm/s), p. 4-19	WE has stated in previous comments that hydraulic conductivities in the range of 1×10^{-5} to 1×10^{-3} cm/s are considered to be moderate according to most references. If the hydraulic conductivity range determined for the alluvial aquifer north of the slough is correct, the yield is expected to be greater than the pump tests results (0.5 gpm) indicate.	The factors affecting groundwater restoration shown on pages 4-18 and 4-19 are drawn from Figure 1 on page 3 of the document *Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration, Interim Final* (Sept. 1993). The determination that a hydraulic conductivity of less than 10^{-4} cm/sec could be considered "low" is based upon the above-cited document, which is an EPA-approved document. (It should be noted that the above-cited document considers a hydraulic conductivity of greater than 10^{-2} cm/sec to be "high.") Information related to the yield of wells within the alluvial aquifer north of the Femme Osage Slough is provided on pages 8-23 and 8-24 of the document *Remedial Investigation for the Quarry Residuals Operable Unit at the Weldon Spring Site, Weldon Spring, Missouri* (DOE/OR/21548-587, July 1997).
29.	232. Section 4.3.2, Compliance with Potential ARARs, p. 4-19, paragraph 1	The description of the Kimmswick Limestone, Decorah Limestone (Group) and the Plattin Limestone (Group) as three separate bedrock aquifers is incorrect. These bedrock units are part of one aquifer group, the Kimmswick-Joachim aquifer (Miller, 1974).	The Kimmswick Limestone, Decorah Limestone group, and the Plattin Limestone are separate lithostatic facies that are part of one aquifer group. The text will be changed to refer to them as separate formations.

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30.	233. Section 4.3.3.2, Protection of the Public, p. 4-22, paragraph 1	WE does not understand the point of the last sentence. Please clarify.	The last sentence of the first (incomplete) paragraph on page 4-22 will be revised to state: "However, with monitoring, information on future concentrations of contaminants in groundwater would be available to confirm the expectation that unacceptable risks would not occur under Alternative 6."
31.	234. Table A.1, Missouri General Protection of Groundwater quality and Resources (10 CSR 23-4.050), p. A-18	There is a slight misinterpretation of these regulations. Well drillers are required to be permitted to install monitoring wells in Missouri. After the monitoring wells are installed, the well driller is required to certify the wells according to 10 CSR 23-4.020 (1).	Table A.1, p. A-18 will be amended to indicate the well construction must be reported to the Division for its review using a certification report form certifying the wells were constructed in accordance with the rules.
32.	235. Section 2, Site Background, p. 7, paragraph 2	Please provide more specific details related to the methods that will be used to "force groundwater flow to go around the inner quarry area or to pass through an attenuation layer". See Comment #233 above.	See response to comment #20.
33.	236. Section 2.1.4, Nature and Extent of contamination, p. 10, paragraph 1	The third entity of contaminated media at the QROU was changed from "contaminated groundwater in the shallow aquifer system (primarily north of the slough)" in the Proposed Plan, June 1997 to "contaminated groundwater in the shallow bedrock (primarily north of the slough)" in the subject document. Because the contaminated alluvial aquifer is a major concern of the QROU, it is suggested that the June 1997 description (which would include the alluvial aquifer) be reinstated in the current document.	Comment noted. The requested text change was made.
34.	237. Comment #68	DOE responds that "Residual contamination remaining in the cracks and fissures of the quarry cannot be removed fully without also removing the bedrock itself." What alternatives have been evaluated to arrive at this conclusion?	It is acknowledged that there is some residual contamination left in the cracks and crevices of the quarry floor. Accessibility was an issue in removing any remaining residual contamination. No alternatives were evaluated to address removal of the bedrock. However, fate and transport of residual contamination in the cracks and crevices was taken into consideration in planning for restoration. The restoration is being designed to prevent resurfacing of any source material (yellowcake flakes). As explained in the original response, the estimated risk to a recreational visitor in the quarry proper was within the acceptable risk range. Restoration will effectively decrease the already low risks estimated for a future visitor in the quarry.
35.	238. Page 11 - 2.1.4.2 Femme Osage Slough and Creeks, Paragraph 1 Sentence 4	*Silver and low levels...........were detected in surface water in the creek only.* Which creek are they referring to or is it both the Little Femme Osage and the Femme Osage Creeks?	Data from the Little Femme Osage Creek and downstream portion of the Femme Osage Creek were grouped together for the comparison with background. Silver was elevated in the creek grouping, but not in the slough. Nitroaromatic compounds were only detected in the Little Femme Osage Creek. To clarify the word "creek" was made plural.

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36.	239. PP, Page 11 - 2.1.4.2 Femme Osage Slough and Creeks, Paragraph 2 Sentence 2	*Uranium, calcium, magnesium....elevated in creek sediment.* Does this apply to both creeks or is it only in the Femme Osage Creek?	This statement applies to both creeks. Data from the Little Femme Osage Creek and downstream portion of the Femme Osage Creek were grouped together for the comparison with background.
37.	240. PP, Page 11 - 2.1.4.2 Femme Osage Slough and Creeks, Paragraph 4 Sentence 2	Species samples form.....The work "form" should be "from".	Comment noted. Corrections made.
38.	241. PP, Page 22 - 4 Summary of Preliminary Alternatives, Alternative 3	Basis for eliminating Alternative 3 seems to contradict the evaluation time for Alternative 6. While the remediation time frame was too long for Alternative 3, DOE feels that two years Is sufficient for evaluating Alternative 6.	The intended purposes of Alternative 3 and 6 differ, in that Alternative 3 is intended to contain (and remove) the potential for contaminated groundwater to migrate south of the Femme Osage Slough, while Alternative 6 was developed to reduce the amount of uranium within the contaminated groundwater north of the slough, thereby reducing the potential amount of uranium that could migrate south of the slough. As noted on page 20 of the document *Rules of Thumb for Superfund Remedy Selection* (EPA/540-R-97-013, August 1997), "remediation alternatives that combine active remediation (in source areas or areas of high concentration) with monitored natural attenuation (in lower concentration portions of the plume) may be most appropriate." As such, a time period of two years to reduce contaminant concentrations in areas of high concentration may be appropriate to attain the remedial objectives.
39.	242. PP, Page 29 - 5.2.2 Compliance with Potential ARARs, Paragraph 1 Sentence 5	*Such a waiver would be supported by performance data....the site.* What factors are going to be measured for performance? Are preliminary goals going to be set for comparison against this performance data?	See response to #17.
40.	243. PP, Page 36 - 6 Proposed Action, Paragraph 4 Last Sentence	*It is expected....will be obtained within the two-year period.* What field determinations will be used to gauge the performance? If it is shown in the preliminary testing for site-specific parameters indicated that yields will be lower or higher than expected, will the action continue after the two years?	See response to #17.